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ECONOMIC TOXICOLOGY

CALIFORNIA annually spends more than a million dollars in the control of insects and fungi infesting citrus trees, and possibly a million more for a like purpose on deciduous trees. To these startling figures may be added no small amount expended in the control of the pests of garden and field crops, stored grain and seeds, and a large sum in the preservation of timber against the attack of wood-destroying fungi. The vineyards need protection from the ravages of mildew. Nor does this conclude the list. There must be added a considerable sum for the control of the parasites of man and beast. Tons of poisoned barley and quantities of expensive chemicals are used to rid the fields of vertebrate pests. The customary way of holding in check this formidable array of pests is by the use of chemicals of various sorts. Of recent years, chemicals have also come to be used to some extent for the control of weeds, and no little interest is being taken at the present time in possible developments in this connection under California conditions. It is said that California is the largest consumer of insecticides and fungicides of any state in the union. The state at least makes use of the greatest variety of these and other economic poisons on account of the great diversity of its agriculture.

These facts, from an economic standpoint alone, justify not only an intensive study of the proper use of the materials, but also a comprehensive study of the materials themselves. This station early recognized the need of the special knowledge of the chemist in the solution of the vexing problems that often confront the investigator who has to deal with the control of pests. Through the publication of Morse in 1887, the utility of hydrocyanic acid as a fumigant for the control of scale insects on citrus trees was first made public.

Under the direction of Professor Woodworth, the activity of the Division of Entomolgy in the investigation of insecticides dates back many years. The early publications of the insecticide laboratory by Woodworth and Colby were among the first to call attention to the need of legislation to protect the consumer against the unscrupulous or careless manufacturer of insecticides. The development by Volck and Luther of a new type of lead arsenate which could be used with safety in the humid coast regions is to the credit of the Division. The later studies by the head of the Division on the complex problems arising in the practical application of fumigation methods are probably the most exhaustive of any similar effort made elsewhere.

The scope of the activities of the insecticide laboratory was enlarged in 1911 to include a study of fungicides. The state insecticide and fungicide law came into operation that year and the chemical work incidental to its administration was assigned to the laboratory. The administration of the law was placed in the hands of the director of this station, although the immediate supervision of the work was assigned to the head of the division of Entomology. The writer became identified with the work at this time.

The most pressing need for chemical study appeared to be the origination and perfection of methods of examination of insecticides and fungicides which were on the market in endless variety and were of such complex composition as to defy ordinary analytical procedure. An intelligent study of analytical methods presupposed some slight knowledge at least of the nature and source of the raw materials and of manufacturing methods in order to know what impurities to look for and to fairly judge their permissible limits in commercial samples.

The reorganized laboratory began work along the lines indicated above, but it soon became evident that it could be of more use to the state than to merely inform the public of the composition of the materials which came to its notice. The greater need seemed to be a more complete knowledge of the toxicology of the materials; a better knowledge of which constituents of the various preparations are active and which inert; the constituents injurious to foliage, and to what extent; the most suitable remedies to choose in order to meet the varied and exacting requirements for the control of pests; and which materials could be mixed with safety and applied in combination.

As opportunity was afforded, the solution of some of these problems was also attacked. It soon became evident that the accumulation of laboratory data alone was wholly inadequate for the solution of many of the problems encountered. A definite effort was made to interpret the results of the laboratory by means of field observations whenever possible.

As a result of these studies, the laboratory has made contributions to agricultural literature from time to time. In this manner and through correspondence and by occasional talks by members of the staff before agricultural audiences, it is felt that the work of the laboratory has been of greater usefulness to both manufacturer and consumer than if the work had been confined more largely to the carrying out of the routine police work of the law.

Another activity of the laboratory has been that of instruction. When the writer first began to collect material suitable for the presentation of a course entitled "Insecticides and Fungicides," it was soon discovered that the great mass of literature on the subject was on the *practical use* of these materials rather than on their composition and properties. Such courses offered at other universities were being given by horticulturists, entomologists, plant pathologists or botanists and the subject was, therefore, discussed from their standpoints. Furthermore, it was found that the students of this college of agriculture were already being well supplied with adequate instruction along these lines by the several divisions. It was clear that it would be inadvisable to offer a course of lectures patterned after the usual lines—largely a reflection of the information already supplied by other courses. There did seem to be a need, however, of a course pre-

sented from the standpoint of the chemist—a discussion of the *composition, properties,* and *toxicology* of the remedies used for the control of agricultural pests. An effort was made to accumulate all available information from this viewpoint; the materials were classified according to active ingredient or derivation rather than according to use as had been heretofore done; and the subject presented accordingly as a three-unit course of lectures.

A one-unit laboratory course was also offered by Mr. Miller, taking up in a practical way the most approved methods of preparation of pest remedies and demonstrating the significance of the simpler tests. The students were divided into groups and each required to prepare the commoner preparations which may be made on the farm, and were given an insight into the underlying principles of commercial manufacturing methods. The use of elaborate apparatus was consistently avoided, only such utensils and measuring devices being used as would be found on the average California ranch. It was thought that if the students were taught the fundamentals of the various processes without any unusual equipment, they would be better able to make use of whatever equipment, simple or elaborate, would be provided them in later years of actual work.

That this sort of instruction filled a want is evidenced by the fact that the enrollment increased from seven the first year to forty the fourth year that the courses were offered.

In the fall of 1915, the laboratory was instructed to undertake an investigation of chemical means for the control of noxious weeds. Sets of experiments have been conducted in five localities, some of which have been under observation for more than two years. These investigations have furnished some very interesting data, both from the practical as well as from the scientific standpoint, the results of which are to be soon published as a progress report.

At first thought, it may seem strange that a study of herbicides was assigned to a chemical laboratory heretofore devoted to the study of insecticides and fungicides. A careful analysis, however, of the toxicological problems encountered in either case discloses a very close correlation of certain phases of the work.

The accumulation, classification, and otherwise making available of an accurate and complete knowledge of the source, manufacture, composition, and properties of the poisons used for the control of insects, fungi, weeds and other pests is work for which the chemist has been trained. When any of these poisons are to be used upon vegetation for the control of insects or fungi, it is fully as important to know their action on plant tissues as their action on the pest, in order to avoid the use of any remedy which may seriously injure the plant. Certain of these poisons can be used at certain times of the year only, or upon certain plants only; others are suitable for use under restricted climatic conditions. Some of these facts are directly applicable to the problem of weed control by means of chemicals. The materials to avoid in the first case may be just the ones to use in the latter case. These observations may be well illustrated by referring to some of the results of this laboratory's herbicide investigations. It is a well-known fact that soluble arsenic (except in very small amounts) is not permissible in any spray which is to be applied to cultivated plants on account of the danger of foliage injury; a completely soluble compound of arsenic was found to be the most effective of any chemical tried for the destruction of weeds. Unpublished experiments by Mr. E. R. de Ong and the writer, testing the action of petroleum oils on foliage, indicated that the constituents of petroleum distillates which are capable of removal by refining with sulfuric acid are very much more toxic to foliage than other constituents; a by-product of oil refineries, containing these highly toxic constituents, was found to be a very effective herbicide.

Quite recently this laboratory has been called upon to analyze a number of squirrel, gopher and rat poisons and to pass on their respective merits, and to answer letters on this subject which were referred from other departments.

It is thus seen that the scope of activities

of the laboratory has steadily (perhaps unconsciously at times) enlarged from a most creditable beginning in the study of insecticides, so that its work included the study of fungicides, then herbicides, and lastly, poisons for the destruction of vertebrate pests. Shall we call the latter "rodenticides" or "zooicides" in order to complete the nomenclature of the list?

The question may be asked: Should not insecticides be studied by the economic entomologist, fungicides by the plant pathologist, herbicides by the economic botanist, and rodent poisons by the economic zoologist? Most certainly they should be. In fact, they have been, and, as a result, the most important contributions to the literature have come from these sources. The questions involved are so complex as to require the application of the special knowledge of all of these scientists. The specially trained chemist may also contribute his share toward the solution of their common problems, a more intimate knowledge of the poisons which may be to a certain degree lacking in the others.

In an organization as large as our experiment station, it is sometimes difficult to avoid duplication of work by the various divisions. One way of avoiding duplication is for each man or group of men to have a very clear and well-defined conception of their respective functions in the machinery of the organization, whether it be a cog, a crank, a governor, or a safety valve, and then to confine their activity to the efficient performance of these functions. A study has been made of what should be the functions of this laboratory and it appears that it will serve the state well if it acquires and disseminates as complete a knowledge as possible of the poisons which are used for the control of insects, fungi, weeds and rodents; insecticides, fungicides, herbicides and "rodenticides."

It has often seemed desirable to make use of a collective term in referring to the materials which are under study by the laboratory. Various names have been suggested, the most appropriate of which appears to be "economic poisons."[1] The qualifying word "economic" serves to distinguish between the poisons which are made to serve a useful purpose in the control of pests and the more popular conception of the meaning of "poisons" as being substances harmful to man. The use of the former is strictly of an economic character and anticipates either direct financial returns, or an improvement of the general welfare of the public. The expenditure of a dollar in the control of crop-destroying pests is not usually justified unless more than a dollar is thereby added to the net returns from the harvest. On the other hand, the poisoning of mosquitoes, flies, rodents, etc., in the interest of public health, does not necessarily involve the question of direct financial return. From both standpoints, the term "economic poisons" seems appropriate as referring to the materials under discussion.

The work of the laboratory has been thus described as having developed into a study of the various poisons, beneficial use of which has been made by society. Toxicology is the science which treats of poisons, their effects, antidotes and recognition. This science, however, has been developed largely among men of the medical profession and deals with the poisons in respect to their harmfulness to man and their use with criminal intent. As undertaken by this laboratory, poisons are studied for an altogether different purpose. Clearly, then, the unqualified word "toxicology" can not be used in this connection without confusion. Inasmuch as the study of poisons in respect to their harmful use has been given the name "toxicology" the term "economic toxicology" will serve to differentiate the study of poisons in relation to the control of pests detrimental to agriculture and to the public health, and may be used to describe the activities of this laboratory.

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[1] The terms ''economic poisons'' and ''economic toxicology'' were suggested by the writer's associate, Mr. M. R. Miller. See this journal, Vol. XLIV., No. 1185, page 264.

ORGANIC SYMBOLS

THE idea to assign an individual symbol to each organic compound, of which over 110,000 are known, seems absurd, impractical and too complicated for a student to master. It would even put the Chinese characters in the background as far as the number of symbols is concerned. Nevertheless a system of organic symbols is not only possible and practical, but also simple and efficient and offers a time- and space-saving device for modern chemistry. In a recent paper[1] such a system of symbols was outlined and some of its advantages have been pointed out. Each symbol represents the structure of the organic compound and indicates furthermore the optical activity, isomeric form and chemical type of a definite organic compound.

The system of symbols is based upon the four elements, hydrogen, oxygen, nitrogen and carbon, while all the other elements entering into a compound are represented by their ordinary chemical symbols. The atoms of these four elements are thought to be points in the symbols, these points to be determined by lines terminating (H), meeting (O and N) or crossing (C). Accordingly hydrogen is a point from which one line radiates, oxygen a point from which two lines radiate, nitrogen three and carbon four lines, radiating respectively. The lines are therefore the bonds or valencies of the respective elements and we have:

Hydrogen Oxygen Nitrogen Carbon

Thus a hydrogen atom is assumed to exist wherever a line ends. Oxygen is supposed to stand wherever a line makes an angle or two lines come together. Nitrogen exists at the point where three lines meet or arise, and carbon is thought to be at a point where two lines cross or four lines radiate. The length of the lines is immaterial. They are straight when representing single bonds and curved when representing double bonds.

With these simple principles all organic structure-formulas can be accurately and exactly reproduced and the resulting geometrical figures or "organic symbols" offer certain advantages worthy of notice:

1. Compactness, for the structure has been brought to a very narrow compass, enabling the extensive use of the symbols where space is limited, *e. g.*, in abstracts and catalogs.

2. Exactness, for each symbol represents only *one* definite organic compound of a definite structure and isomeric form.

3. Accuracy, for it is impossible to write for a given compound a structure symbol which is *not* theoretically correct, provided the simple rule regarding H, O, N and C is followed.

4. Clearness, for the design of the symbols of certain types of compounds is distinct and helps the student to remember the characteristic structure of a group of compounds or a radical like —COOH, etc.

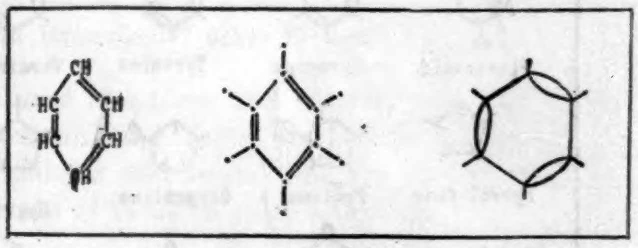


FIG. 1. The Organic Symbol for Benzene.

5. Simplicity, for with a very few rules thousands of compounds can be constructed and readily understood.

In Fig. 1 the comparatively simple transformation of the structural formula of benzene to its organic symbol is schematically represented, while Fig. 2 shows a comparison

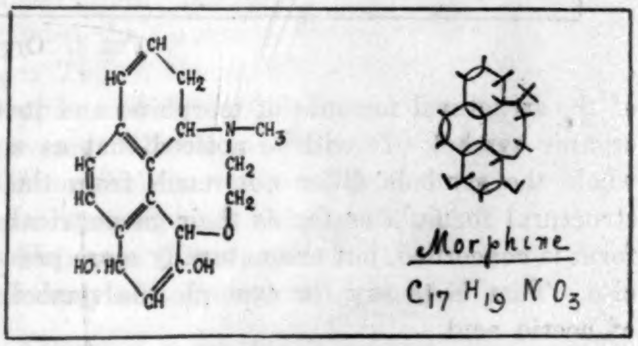


FIG. 2. The Organic Symbol for Morphine.

[1] *Canadian Chemical Journal*, Vol. 2, p. 135, May, 1918.

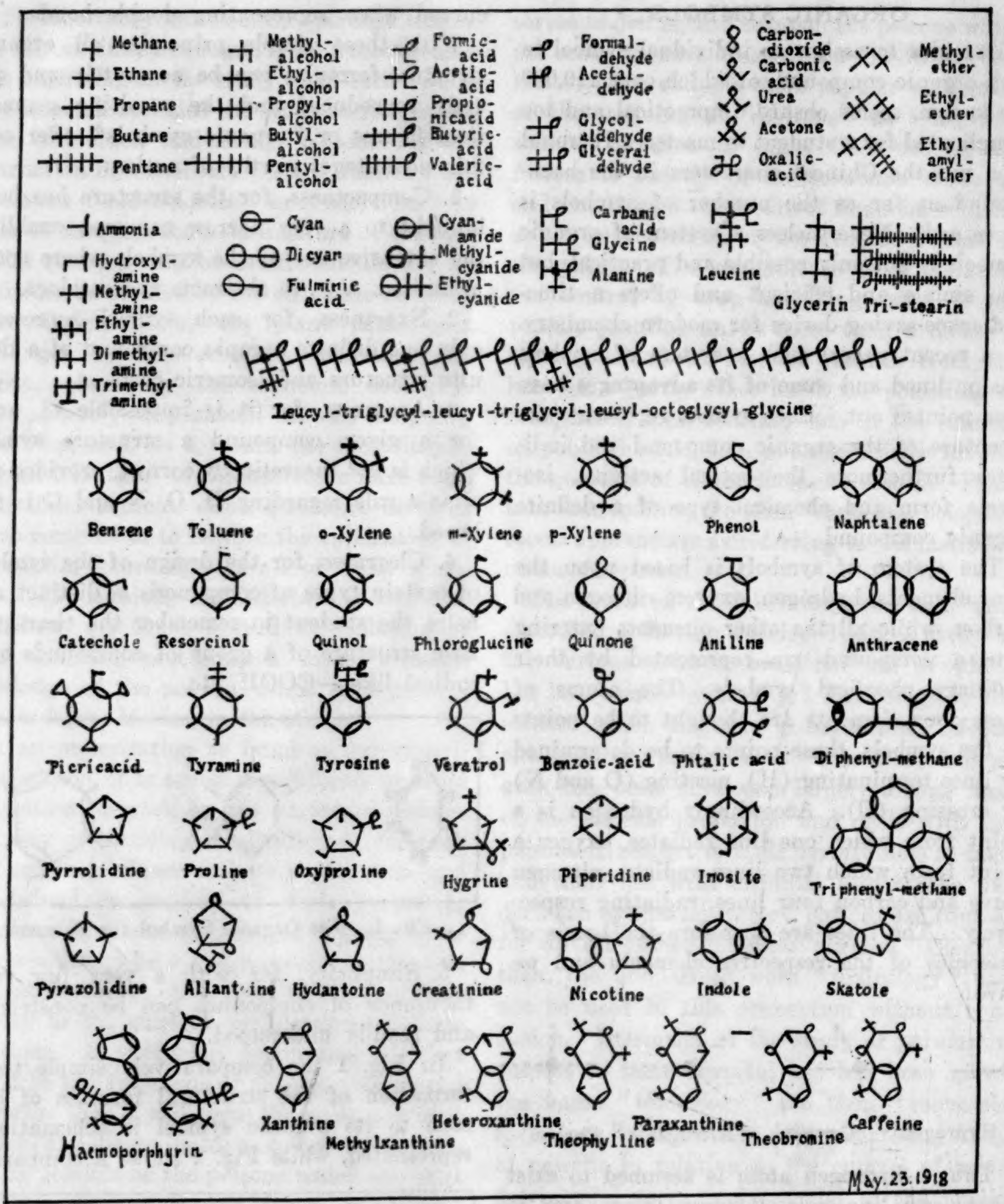
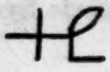


FIG. 3. Organic Symbols.

of the structural formula of morphine and its organic symbol. It will be noticed that as a whole the symbols differ not much from the structural formula as far as their geometrical form is concerned, but are naturally more precise. That is to say for example the symbol of acetic acid



does not only mean $CH_3.COOH$, but actually

$$\begin{array}{l} \mathrm{H} \\ \mathrm{H{\cdot}C{-}C{:}O} \\ \quad\cdot \qquad \cdot \\ \mathrm{H} \quad \mathrm{O{\cdot}H} \end{array}$$

and is therefore much more exact by recording not radicals but each atom separately.

In Fig. 3 is a list of some typical symbols for different classes of compounds. A dot (*e. g.*, in leucine) indicates an asymmetric carbon-atom and thus the optical active compounds are characterized. The long decorative design represents an octodeca-peptide or artificial peptone. Of the ring compounds mainly simple representatives have been selected, but some of the purin-bases at the bottom of the table (xanthin and derivates) show the simplicity of complex-rings. It will be noted that the different derivates are very plainly shown in their relationship, differing in that case only by the addition of one, two or three —CH_3 groups (crosses in the symbols). Hæmoporphyrin, the mother substance of hæmatin of the hemoglobin of the blood, is an example of the more complex structures which recent investigations have disclosed.

With the rapid progress in organic chemistry and the structures of compounds becoming more and more complex, the need for a simple device of recording facts becomes apparent and I am indebted to the late Dr. Henry S. Denison, whose suggestions[2] on a "chemical shorthand" caused the working out of the present system of "organic symbols." While the system is still in the precarious state of development, it is necessary to warn against indiscriminate use of the principles involved in constructing symbols. An indiscriminate application would lead to confusion and for this reason certain standard types of symbols must be established. These standard types must or should conform as far as possible to the theories concerning the arrangement of the atoms in the molecules. A ring of six atoms would be represented by a hexagon, and not by a square, one of five atoms as a pentagon and so on (compare, *e. g.*, xanthin).

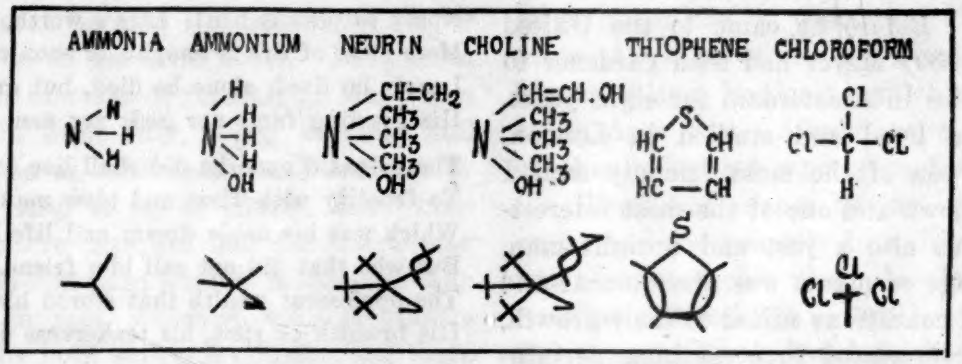


FIG. 4. Pentavalent Nitrogen and Examples of other Elements.

In certain cases nitrogen possesses a valency of five and in Fig. 4 the relationship of these symbols is shown. Also the use of the ordinary symbols in connection with organic symbols. S = sulfur in thiophen, Cl = chlorine in chloroform.

The writer has already employed the system in one of his classes with success and found it a time- and space-saving medium in transmitting facts of organic chemistry to students and hopes that the system may become of value to other scientists.

INGO W. D. HACKH

BERKELEY, CALIF.

[2] *Denver Medical Times*, Vol. 31, p. 360, 1912.

FRANK N. MEYER[1]

MEYER was in the second year of his third great Middle Asiatic Exploration. His first trip of two years covered North China, including Mantchuria, in which province he walked 1,800 miles. His second trip of three years included the Caucasus, Persia, Turkestan, eastern Thibet, the middle districts of the great empire and Japan. His third trip was to have covered all the more southern portions of China likely to contain plants useful to western agriculture. During these seven years which were full of strange adventures he made thousands of interesting observations, penned

[1] Drowned in the Yang-tsze-kiang, June 1, 1918, and buried in Shang-hai, China.

copious records, took hundreds of superb photographs and secured a great variety of interesting and useful plants, many of which are now growing in the United States. Previous to these trips he had visited all parts of the United States and had walked across central Mexico, sleeping in Indian villages or on the mountain sides. Earlier in life he walked from Holland to Italy, guided only by his compass, and nearly lost his life in the Alps, overtaken by a snow storm. The first person he met in Italy said: "Where did you come from?" and then "Impossible! There are no roads!" when he replied "From over the mountains." Before he came to the United States (in 1900) Meyer had been gardener to Hugo de Vries in Amsterdam for eight years. He had also lived and studied in London. Meyer was one of the most friendly men I have ever known and one of the most interesting. He was also a just and upright man. His knowledge of plants was phenomenal and especially of conditions suited to their growth, but he was interested in everything pertaining to the countries he visited—climate, topography, fauna, flora, geology, ethnology, art archeology, religion. He was an entertaining public speaker, as many can testify, a good conversationalist and a copious and fascinating letter writter. A published volume of his letters would be as interesting as a novel, more interesting than most novels. He had also a gift for linguistics, being most at home in Dutch, German and English, but knowing also something of French, Spanish, Italian, Russian and Chinese. On the whole, Meyer preferred the United States to any other country and had become a citizen, but the narrowing conventions of our social life irked him a good deal at times—"The sky is too near" was his whimsical way of putting it—and after a few months of Washington life there was always a longing for the free air of the wilderness. Grand mountain scenery in particular appealed to him strongly. Early in life he spent a year in a Dutch social colony, a kind of second "Brooke Farm," founded by the poet Dr. Frederik van Eeden, but the serpent of selfishness was there also, he told me. In philosophy Meyer was a follower of Schopenhauer; in politics a Marxian Socialist; in religion a Buddhist. It is not known how he met his death. He was ill at the time, it is said, and disappeared in the night from a river steamer. He was in middle age, of medium height, stocky, broad-shouldered, strong. He had blue eyes, brown hair, a big beard and regular features.

O brother of all men and faithful friend,
By riddle of the world made desolate,
'Tis meet an Asian flood should be thy fate,
By *Welt-Schmerz, Welt-Gang* driv'n to sad life's end!

Nobly to plan is life! Life's worth, its trend;
Mere close of life is naught, or soon or late!
Lonely he lived, alone he died, but great!
His growing fame nor gods nor men forfend!

The splendid good he did shall live and grow
To fructify with Time and bless mankind,
Which was his noble dream and life-long goal!
But who that did not call him friend shall know
The opalescent wealth that stored his mind,
His breadth of view, his tenderness of soul!

Erwin F. Smith

SCIENTIFIC EVENTS

RUSSIAN WHEAT

The *Bulletin* of the Neuchâtel Geographical Society (vol. 26, 1917) contains an elaborate paper by Léon Felde on the "Production and Export of Russian Wheat." According to an abstract in the *Geographical Journal*, the first part (pp. 80) discusses very fully, if not very deeply, the whole question of production—soil, climate, technical and social conditions; the second part does the same for the commerce, dealing with the internal and external transport from all points of view, but specially with exports to Switzerland. It is a very useful compilation, marred only by some rigidity, *e. g.*, the fixing of germination at 6° C. and the accumulated temperatures being stated definitely as 2000°, the relation of higher accumulated temperatures to latitude and higher mean temperatures being thus ignored.

The spring-wheat area falls, typically, within the area of highest general culture. It lies parallel with the rain-bearing winds—north

eastwards from the Sea of Azov, along isotherm 22° C. (*c.* 71° F.) in July, while the winter-wheat area lies athwart the winds, parallel with the Black Sea coast, especially southeast of the Azov, *i. e.*, along isotherm—4° C. in January. The spring-wheat area is, therefore, associated with greater range of temperature (having an average of —10° C. in January), as also with greater variation of yield, this having varied from 58,000,000 cwts. in 1906 to 148,000,000 in 1913; and such variation helps to account for the excessive variation in price, which even at Odessa varies from 29 per cent. below normal to 32 per cent. above, while at Saratov it varies from 35 per cent. below to 62 per cent. above. Both areas have sudden increase of rainfall in May, then maximum in June-July, a dry autumn, and some increase of rain again in November or December. And it is, of course, the "temperate" winters that are bad for the winter wheat (p. 27)—in hard winters it seems to take no harm. In fact, wheat-growing is greatly facilitated by both soil and climate, but there are at present insuperable difficulties against introducing intensive culture, although the wheat area has—for Russia—quite a dense population (25 to 70 per square mile). In the absence of scientific agriculture, the result of this comparative density is that only sixteen governments, out of c. 70 in European Russia, have normally any surplus wheat for export; and this surplus is based on a per capita consumption of 150 pounds in 1913, as against 60 pounds in 1906. Still, cereals make two thirds of the total value of Russian exports, wheat having over one third of the total cereal value. The transport is by both water and rail, the useful "floatage" being estimated at c. 90,000 miles and the navigable water at c. 28,000 (excluding Finland), and an annual duration varying from an average of 263 days (with a range of 50) on the Dnieper, to one of 231 days (with a range of 29) on the Don, and one of 223 (with a range of 67) on the Lower Volga. The statistical returns emphasize in the most marked way the insignificance of Odessa as a wheat port. For some years it has never been in the list of the first six. It is generally far behind its two neighbors of the Dnieper liman, Kherson and Nicolaiev—the latter, as an important railway junction on the only line to Kherson and with a much wider river, having the steadier trade of the two. All three together were not equal to Rostov in 1913, with its 17 per cent. of the total Russian export, while even Riga is usually at least as important as Odessa. The sheltered "Riviera" port of Novorossiskaya, the terminus of the Volga line from Tsaritsin, comes next to Rostov, with c. 9 per cent. of the total export and has a very steady trade; and Taganrog usually stands third, though large quantities of wheat are exported from other Azov ports, *e. g.*, Yessk, Berdiansk, Mariupol and Feodosia—which really counts as an Azov port. Altogether, c. 45 per cent. of Russian wheat exports go from the Azov, the Black Sea proper having only c. 40 per cent.; and the quantity in millions of pounds roughly approaches the value in millions of roubles (203 and 225 in 1913). For years before the war Russia had furnished Switzerland with her chief supplies of wheat, though by 1912 the proportion had fallen slightly below 50 per cent., while it was only 36 per cent. in 1913. The grain moved via Genoa or Marseilles or Mannheim, some going on as far as Strassburg or Kehl; and the manipulation of dues on the German railways was such that, though the water rate to Mannheim was c. 1,400 francs per quintal as against 800 to Genoa or Marseilles, the total cost to Berne was only c. 3,200 francs as against 3,070 via Genoa and 3,300 via Marseilles. The saving to Zurich was 300 francs greater. The extra time for delivery to Switzerland via the Rhine was 20 days.

THE SUPPRESSION OF BODY-VERMIN

A COMPREHENSIVE paper entitled "Combating Lousiness among Soldiers and Civilians," by Professor G. H. L. Nuttall, appears in *Parasitology* for May. According to an abstract in *Nature*, the paper is one of a series which when complete, will constitute an exhaustive monograph on human lice. It brings together, not only the available published

information, but also that resulting from hitherto unpublished research work, partly the author's own, and partly that of others contained in reports to the War Office, which he has been permitted to use. Professor Nuttall has generously presented a special edition of three hundred copies of the paper to the Allied Armies; and, in view of the recently established fact that the trench fever is conveyed by lice, this should prove a very timely gift.

The paper comprises 176 pages, with four plates and twenty-six figures in the text. Most of the pages are devoted to the practical consideration of louse destruction a great deal of the experimental evidence being given in detail. The results obtained demonstrate that nits are killed by dry heat at 65°–70° C. in one minute, and at 55°–61° C. in ten minutes, the active stages being killed by dry heat at 65°–70° C. in one minute and at 55° C. in five minutes. After allowing for a margin of safety in practise, immersion in hot water at 70° C. for a minute or two is amply sufficient to destroy lice, while 55° C. for ten minutes is equally effective, a point of great importance in relation to the washing of flannel garments.

Singeing, sun-baking, and the use of hot flat-irons are briefly dealt with. The various methods devised for disinfection by hot air and steam are treated of at length, and illustrated by text figures of disinfestors improvised for war purposes, together with plates depicting the more elaborate forms of disinfestors designed for use in peace time. We agree with the author that apparatus designed with a view to high efficiency against the resistive spores of bacteria is not adapted for rapid and economical use against lice. It should be replaced by more commodious hot-air and steam huts, or disinfectors planned on the improvised railway vans said to have been so successful in the east. Designs of this type of chamber should also be adapted for steam or motor lorries, as well as trailers, which could, if necessary, be horse-drawn.

Steam gives results superior to hot air if the destruction of pathogenic bacteria is an object, but dry heat possesses many advantages over steam if the destruction of body vermin is the end in view. The use of sulphur is treated of at some length. We endorse the author's remarks as to the failure of sulphur vapor to destroy all the nits exposed to it, while its relatively high cost, the danger of injury to clothing and its slow action are further disabilities of the method.

In the section dealing with insecticides and so-called repellents, the results of the great mass of experimental work are tabulated in detail, an unavoidable course owing to the wide diversity of method employed by the various workers. In these experiments lice and nits were immersed in, brought into contact with, and submitted to the action of the vapor of various substances and preparations.

THE FUR SEALS OF THE PRIBLOF ISLANDS

In the present calendar year to August 10, the end of the regular killing season, 33,881 sealskins were taken at the Pribilof Islands. Of these, 7,000 were taken on St. George Island and 26,881 on St. Paul Island. The Department had authorized a take of 35,000 skins, 7,000 on St. George and 28,000 on St. Paul. Some few seals will be killed from time to time during the remainder of the year for the purpose of furnishing fresh meat for the natives.

By the terms of the North Pacific Sealing Convention of July 7, 1911, 15 per cent. of this year's take of skins belongs to the Canadian government and a like proportion to the Japanese government. There will be no actual delivery of these skins, but, under the provisions of the convention, the market value of the skins will be credited to the respective governments as an offset to certain advance payments made to them by the United States.

A census of fur seals on the Pribilof Islands was conducted by G. Dallas Hanna, and preliminary figures, subject to slight modification when all the data have been carefully examined, have been received. The number of pups born was 143,005, and the number of breeding cows was the same. The approximate total size of the Alaskan herd was 496,-

600. The average harem, based on a count of seven rookeries, was 26.76. The census was of date of August 10, and did not include the 33,881 seals taken during the present calendar year.

Reports have been received from the superintendent and physician, United States Indian Service, Neah Bay, Wash., that he has authenticated 386 fur-seal skins taken this season by Indians dwelling on the coast of Washington. The seals were all speared from canoes and were taken from 10 to 25 miles west of La Push, Wash. The records show that 379 of the skins were taken in April, May and June, 1918, and that 245 of the seals were males and 139 females. The superintendent also stated that a few skins remain untagged, and a report on the number will be made at the close of the season.

The lighthouse tender *Cedar*, which had on board some of the heavier portions of the equipment for the new by-products plant for St. Paul Island arrived at the island on August 11. The material was successfully landed, and ground for the foundation of the plant was broken on the 14th. The balance of the equipment for the plant was delivered by the *Roosevelt* in August. The active sealing operations were over by the 10th, thereby permitting the energies of the station to be devoted largely to the erection of the plant. It is hoped to push the work of constructing the buildings and installing the machinery rapidly to completion and to begin the manufacture of oil and fertilizer from seal carcasses this season. The carcasses of approximately 27,000 seals which have been killed on St. Paul Island this year will furnish ample material for preliminary operations.

RESEARCH GRANTS FROM TRUST FUNDS OF THE NATIONAL ACADEMY OF SCIENCES

DURING the twelve months preceding the annual meeting of the academy the following grants for the promotion of research were made from the trust funds of the academy.

GRANTS FROM THE BACHE FUND

No. 205, T. H. Goodspeed, University of California, $100. For studies of inheritance in *Nicotiana* hybrids.

No. 206, Reginald A. Daly, Harvard University, $700. For the completion of the deep sea thermograph designed and partly constructed under Grant No. 194. In continuation of No. 194.

No. 207, T. H. Gronwall, New York City, $300. To complete and extend mathematical researches on conformal representation.

No. 208, A. Franklin Shull, University of Michigan, $400. To investigate the cause of sex production and the life cycle of rotifers, together with artificial modification of life cycle; differential factors in fertilization of male-producing and female-producing rotifers; sex determination and the life cycle of the thrips; cause of sex production, wing production and other cyclical phenomena in aphids.

No. 209, Cecil K. Drinker, Harvard Medical School, $350. For the closer study of the factors involved in extension of unchecked red cells and leucocytes in the dog.

GRANTS FROM THE WATSON FUND

No. 16, Herbert C. Wilson, Goodsell Observatory, $300. For a continuance of the work of the determination of the position and brightness of asteroids (chiefly those discovered by Watson by the photographic method, together with a study of the brightness of some variable stars. (Supplementary to Grant No. 15.)

No. 17, John A. Miller, Sproul Observatory, $500. To measure plates for determining stellar parallaxes. (Supplementary to Grant No. 14.)

GRANTS FROM THE J. LAWRENCE SMITH FUND

No. 9, S. A. Mitchell, University of Virginia, $300. To continue his researches on the paths, radiants and orbits of meteors. (Supplementary to Grant No. 8.)

GRANT FROM THE MARSH FUND

No. 2, M. Ferdinand Canu, Versailles, France, $250. For investigation in cooperation with Dr. R. S. Bassler, of the United States National Museum, of the early tertiary bryozoa of North America.

SCIENTIFIC NOTES AND NEWS

PROFESSOR ERNEST FOX NICHOLS, of Yale University, has been given further leave of absence to continue his work in the Ordnance Department.

LIEUTENANT COLONEL DR. JOHN M. T. FINNEY, surgeon-in-chief of the American Expeditionary Forces, on his recent visit to the United States laid plans before the President

for the establishment of hospitals for the treatment of shell shock. The necessary funds have been provided and Dr. Finney has returned to France.

A mission headed by Colonels Combe and Dr. Lure has been sent to France by the Canadian government for the purpose of studying the measures that have been taken in reconstruction work among the maimed and the invalided.

Professor Hiram Bingham, of Yale University, who is a lieutenant colonel in the Aviation Section, Signal Corps, of the Regular Army, has been appointed chief of the Personnel Section in the office of the Chief of the Air Service, American Expeditionary Forces.

Dr. Ralph G. Van Name, of Yale University, has qualified as chemist in the government service.

Charles V. Bacon was commissioned a captain in the Engineer Reserve Corp on July 2 and is now stationed at the General Engineer Depot, Washington, D. C., in the Division of Investigation Research and Development, being a member of the executive committee. Captain Bacon was formerly associated with the American University Experiment Station as chief of the section on flaming liquids, and later as chief of the section on oil research.

Chas. N. Jordan, formerly instructor in chemistry, Marvin College, Fredericktown, Mo., is now engaged in chemical and metallurgical work for the Ordnance Department.

Dr. R. E. Nelson has resigned his instructorship in chemistry at Purdue University to accept an appointment as assistant gas chemist in the Research Division, Chemical Warfare Service, American University Experiment Station, Washington, D. C.

At the Oregon Agricultural College, Dr. A. C. Chandler, assistant in the department of zoology, and F. H. Lathrop, research assistant in entomology, have received commissions as second lieutenants in the Sanitary Corps and have been granted leave of absence for the duration of the war.

Professor C. K. Leith, of the University of Wisconsin, has been appointed mineral adviser to the War Industries Board from the standpoint of the conservation of shipping.

President Kenyon Butterfield, of the Massachusetts Agricultural College, has become a member of the Army Educational Commission appointed to provide educational opportunities for the American Expeditionary Forces.

Dr. R. A. Pearson has resigned as assistant secretary of agriculture so that he may resume his duties as president of the Iowa State College of Agriculture. He will be succeeded by G. I. Christie.

At the Bureau of Fisheries Glen C. Leach, field superintendent, has been promoted to the position of assistant in charge of the division of fish culture, in succession to Henry O'Malley.

Mr. Henry M. Eakin, formerly with the Alaska Division of the U. S. Geological Survey, has entered the employment of a large lumber company in Alger, Washington, as topographer and forester.

Dr. R. P. Calvert has been transferred from the position of head of the general chemical division of the Experimental Station, Wilmington, Del., to that of director of Delta Laboratory, Arlington, N. J. Both laboratories are under the direction of the chemical department of E. I. du Pont de Nemours & Company.

Charles S. Rewe, chemist of the United States Office of Public Roads and Rural Engineering, has entered the Research Department of the Barrett Company, New York City.

N. H. Darton, of the United States Geological Survey, spent August and September in New Mexico continuing his investigation of stratigraphy of the Red Beds especially as to their prospects for containing potash deposits.

Professor Maxwell-Lofroy, professor of entomology at the Imperial College of Science, London, has accepted a year's engagement with the Commonwealth Government for £3,000, plus £2,000 for experiments. He will investigate the blowfly, the grain weevil, the woolly aphis, prickly pear and the St. John's wort.

DR. C. CHILTON, professor of biology at Canterbury College, New Zealand, has been elected an honorary member of the Royal Society of New South Wales.

PROFESSOR AARON NICHOLAS SKINNER, formerly professor of mathematics at the U. S. Naval Academy and assistant astronomer of the Naval Observatory, died on August 14, in his seventy-fourth year.

MR. ROBERT CHRISTIAN MCKINNEY, for many years a member of the topographic branch of the U. S. Geological Survey, has died on July 27, at the age of sixty-two years.

COLONEL BERTRAM HOPKINS, professor of mechanism and applied mechanics in Cambridge University, died on August 26 in an aeroplane accident.

PROFESSOR O. HENRICI, F.R.S., emeritus professor of mechanics and mathematics in the Central Technical College of the City and Guilds of London Institute, died on August 10, at the age of seventy-eight years.

STONEHENGE, the famous Druid monument, which has always been in the hands of private owners, has been presented to the British nation by C. H. E. Chubb, who purchased it in 1915.

THE statutory meeting of the general committee of the British Association for the Advancement of Science, was held in London in July, and at this meeting much disappointment was expressed that for the second year in succession it has been found impossible to arrange for an ordinary meeting. A resolution was passed unanimously asking the council to arrange for a meeting in London next year, if it should prove impossible to arrange to meet at Bournemouth. The question as to the type of meeting which it was desirable to hold was left to the council to decide.

THE Illuminating Engineering Society will hold its annual convention at the Engineering Societies Building, New York, on October 10, 1918. War-time lighting economies, the use of better lighting in speeding up war production and manufactures, the lighting of camps, effect of lighting curtailment on crime, and automobile headlight laws will be discussed.

THE Association of American Agricultural Colleges and Experiment Stations will hold its thirty-second annual convention at the Southern Hotel, Baltimore, Md., November 13-15.

THE council of the Royal Microscopical Society announces that the high cost of printing and the growing scarcity of paper have compelled them to reduce the issue of the *Journal* to four numbers per annum instead of six. The revenue account of the society for 1917 showed an excess of expenditure over income of £141.

THE committee of organization for the South American Conference on Hygiene, Microbiology and Pathology, to be presided over by Professor Couto, has decided on Rio de Janeiro for the inaugural session. It will convene on October 15. The previous meeting was held at Buenos Aires in September, 1916.

THE *Journal* of the American Medical Association states that the commission sent by the National Public Health Service to study epidemic diseases in northern Argentina is under the leadership of Professor Kraus, director of the Instituto Nacional Bacteriologico. The other members of the commission are Drs. de la Vega, Battaglia, Barbara, and Fischer, with several bacteriologists, *guardas sanitarios* and attendants. The epidemic of pneumonia at Jujuy has almost completely died out, but the mortality reached 30 per cent. In the Galpon and Molinos districts there have been cases suspicious of bubonic plague and the commission is to investigate these foci. A large squadron is equipped for rat destruction at these places. The main interest for the expedition, however, is the investigation of typhus, for exanthematous typhus has never been reported before in Argentina. The suspicious cases which the commission is to study have occurred at Iruya, near the frontier of Bolivia, in a poor, mountainous zone with little communication with the outside.

Nature states that the position of Great Britain as regard the supply of optical glass at the outbreak of the war is often not clearly understood. Optical glass has been manufac-

tured in this country since 1848 by Messrs. Chance Bros., and Co., Birmingham. When the supply of German glass was cut off in 1914, the experience gained by this firm became an important national asset, and through it an acute situation was saved. Messrs. Chance have supplied nearly the whole of the optical glass required for instruments used by British forces during the war, and also much of the requirements of the Allies, without any assistance from the formula determined by the Glass Research Committee of the Institute of Chemistry. This committee rendered invaluable aid to the manufacture of scientific and heat-resisting glassware, but the needs of optical-instrument makers were met independently by Messrs. Chance, whose output since the outbreak of hostilities has increased twenty-fold. Without their seventy years' experience it would have been very difficult to have produced the supply of optical glass imperatively demanded by conditions of war.

President Wilson has issued a proclamation establishing three new national forests in the East—the White Mountain, in Maine and New Hampshire, the Shenandoah, in Virginia and West Virginia, and the Natural Bridge, in Virginia. The White Mountain National Forest is located in Grafton, Carroll and Coos counties, N. H., and Oxford county, Me. The Government has actually taken title to about 267,000 acres, and in addition about 124,000 acres more have been approved for purchase, making a total of about 391,000 acres under Federal protection. This forest protects in part the watersheds of the Androscoggin, Saco, Connecticut and Ammonoosuc rivers. The Shenandoah National Forest is situated in Rockingham, Augusta, Bath and Highland counties, Va., and Pendleton county, W. Va. The government has acquired to date slightly in excess of 100,000 acres and an additional area of approximately 65,000 acres has been approved for purchase, making a total of approximately 165,000 acres under Federal protection. The forest is for the most part on the watershed of the Shenandoah river and it also protects a portion of the watersheds of the Potomac and the James. The Natural Bridge National Forest is situated in Rockingham, Nelson, Amherst, Botetourt and Bedford counties, Va. The federal government has actually acquired title to a little over 73,000 acres, and an additional area of approximately 29,000 acres has been approved for purchase. The forest, which protects a portion of the watershed of the James river, does not include the Natural Bridge, but this scenic feature is within three or four miles of the boundary.

As a means of combating tuberculosis and other communicable diseases besides elevating the general health conditions throughout the state, the Oklahoma Association for the Prevention of Tuberculosis is conducting a series of general surveys of cities throughout the state. The surveys are in charge of Mr. P. Horowitz, of the department of biology and public health, Massachusetts Institute of Technology, and Dr. Gayfree Ellison, professor of bacteriology and hygiene of the University of Oklahoma. The investigators are assisted by members of the executive and nursing staff of the State Association, as well as by the staff of the State Board of Health and the Board of Argiculture. The surveys, which began on April 1, are continued through the month of September. The following towns are included in the study: Oklahoma City, Tulsa, Muskogee, Enid, Shawnee, Bartlesville, Ardmore, Chickasha and McAlester.

The United States Bureau of Education has recently issued a Union List of Mathematical Periodicals prepared by Professor David Eugene Smith and Dr. Caroline Eustis Seely. This list contains the leading mathematical periodicals needed by research students and to be found in a number of the larger libraries in various parts of the country. Copies may be secured by addressing the United States Commissioner of Education, Washington, D. C.

A historical sketch of the observatory of the University of Cincinnati has recently been written by Dr. J. G. Porter, director of the observatory. The Cincinnati Observatory has been in operation since 1843, when it was

established by Professor O. M. Mitchell, professor of astronomy in the old Cincinnati College. Through the generosity of Nicholas Longworth a site for the observatory was secured and telescopes were mounted in 1845. In 1873 the observatory was made the astronomical department of the University of Cincinnati, and the present site on Mt. Lookout was donated by John Kilgour. Professor Mitchell was an innovator, publishing the first American magazine devoted to popular astronomy, and applying the principles now embodied in the chronograph to the recording of time. The scientific achievements of the observatory are well known, among them being the detection of double stars, orbits of comets, prediction of the weather and the study of nebulæ. For years the problem worked on by Dr. Porter and his assistants has been the proper motions of the stars. The few thousands of stars which show sufficient motion to be perceptible, in the interval during which astronomers have had them under observation, have been reobserved at Cincinnati and their motions carefully investigated.

UNIVERSITY AND EDUCATIONAL NEWS

STONYHURST COLLEGE, Blackburn, England, has planned to raise £20,000 as a war memorial to be devoted chiefly to the erection of new science laboratories.

COLUMBIA UNIVERSITY, at the request of the War Department, is starting an emergency course in engineering for students entering from high schools. This emergency course, embracing civil, electrical, mechanical, metallurgical and chemical engineering, will extend over two years of four quarters each. The first four quarters of the course will be devoted largely to fundamental scientific training in mathematics, physics and chemistry. The strictly engineering subjects will come in the second year. The War Department does not guarantee that any man entering on this course can remain to finish it, but those who do well will be continued in it as long as the needs of the army permit.

LIEUTENANT COLONEL CHARLES F. CRAIG, who until recently has been stationed at Fort Leavenworth, Kans., has been placed in charge of the Yale Army Laboratory School, the new school for bacteriologists and chemists which is to be conducted at Yale University during the period of the war.

DR. R. M. STRONG, professor of anatomy at Vanderbilt University, has been appointed professor and head of the department of anatomy at the Chicago College of Medicine and Surgery.

DR. JOSEPH C. BOCK, Chem. Eng. (Vienna), Ph.D. (Cornell), for five years instructor at Cornell University Medical School, has been appointed professor of physiological chemistry in the school of medicine of Marquette University at Milwaukee.

E. J. QUINN, who for the past four years has been a research chemist on the chemistry staff of the Montana Experiment Station has accepted an appointment as assistant professor in the department of chemistry of the State College of Agriculture and Mechanic Arts of the University of Montana. He will have charge of the courses in analytical and agricultural chemistry.

MR. S. H. STROUD, formerly demonstrator in chemistry in the School of Pharmacy, Bloomsbury Square, has been appointed lecturer in pharmacy and chemistry in the University of Sydney, N. S. W.

DISCUSSION AND CORRESPONDENCE

THE FOUNDATIONS OF MECHANICS

IN SCIENCE of August 2, Messrs. Franklin and MacNutt attempt to make it "clearly evident that Professor Huntington's statement (that variation in acceleration from body to body for a given force is logically derivable from the variation from force to force for a given body) is not true." "Logically derivable" is scarcely a clear phrase in this connection. The *quid* of the matter is found, of course, in the fact that in the table of Messrs. Franklin and McNutt, these authors

have chosen to use three "identifiable" forces. According to their logic, they must mean that their forces are identifiable but not measurable, and further that you can not measure force until you bring in the idea of mass. The distinction between "identifiable" and measurable" seems to me to be valueless. Moreover, mass is in no way *necessary* either for the identification or measurement of forces. As Perin[1] observes. if a stretched spring A balances two stretched springs $M + N$, then force $A =$ force $M + N$. Messrs. Franklin and McNutt emphasize the fact that mass is independent of time and place and exists independent of any gravitational field. So does the science of mechanics. Messrs. Franklin and McNutt's own logic should, then, force them to the conclusion that for all bodies, where F is measured independently of mass

$$f/a = \text{constant} = m \qquad (1)$$

and the constant is defined as mass.

A much deeper source of confusion is found, however, in not making the distinction between mechanics as a "doctrinal function" to borrow Bertrand Russell's term and as an experimental science. If we put

$$x = y/z \qquad (2)$$

we have asserted nothing, since no interpretation has been placed on x. y and z. So, in fact, we might go ahead and develop the whole of (mathematical) mechanics without interpreting the symbols at all, or specifying merely that they might be anything consistent with the fundamental equations or postulates and of course with the theorems deduced. Such a body of doctrine is Veblen's[2] system of axioms for geometry. The system has no necessary connection with space or geometry at all; but when for the one undefined element, we put "point" the doctrinal function becomes applicable to space. But we could substitute something else—and that non spatial—and get an equally good application. So if we let $x = m$, $y = f$ *and* $z = a$, we have equation (1), which we assert is true from experience or experiment.

There is of course no objection to having as many postulates as we please or as the case requires provided they are consistent. Elegance also requires that they be independent. For a start, let us put

$$m = f/a \qquad (1)$$

$$f = k(m_1 m_2/r^2) \qquad (3)$$

where K is the constant of gravitation. These two postulates are obviously both consistent and independent. There is a double definition of mass,—*i. e.*, mass as inertia, and mass as capacity to be attracted in a gravitational field. In the doctrinal function we *postulate* the *m's* (whatever they represent, if anything) identical. By experiment we say mass by one definition equals mass by the other. Similarly, a chemical compound is something that (at least) fits into the equations of Gibbs' paper "On the Equilibrium of Heteoogeneous Substances." It is intended, of course merely to indicate a line of thought, not to develop it.

Thus it is clear that the units we have in the Bureau of Standards need not be the same as the undefined elements in the doctrinal function. We do not need even to imagine that Bureau keeping standard springs, rubber bands, strong armed men, etc., and more than it would have to keep a standard point (!) instead of a standard meter, for Veblen's system of geometry. Any equation may be made use of to measure any quantity which it contains.

There remains the formal possibility that we might find by experiment that the mass of (1) is not the same as the mass of (3). A doctrinal function corresponding to mechanics would not be affected, but a new one would have to be made corresponding to the new experimental fact, provided we wished to define mass, in part, by making use of gravitational pull, that is, to retain a postulate comparable to (3) along with (1). But this last is not necessary, since $f/a = m$ is a sufficient definition of mass, and has nothing to do with

[1] Perrin, "Traité de Chimie physique," Paris, 1903.

[2] *Transactions of the American Mathematical Society*, Vol. 5, p. 343.

gravitation that we can explain further. It is the real definition of mass, and (3) is a useful additional postulate, or a useful experimental fact.

So far as ease of thinking is concerned, which is more or less irrelevant, force and acceleration are far more easily grasped than mass. That is to say, it appears so to the writer; but Frederic Soddy[3] says: "the conception of force and its pseudo physical reality undoubtedly delayed for centuries the recognition of the law of the conservation of energy. Only what is conserved has the right to be considered a physical existence. In other branches of science, the conception is a stumbling block and a delusion." Perrin takes a radically different view. There seems to be a certain mysticism in Soddy's contention, for what do we care whether a force goes on "existing" when we finish with it? We find velocities and temperatures convenient, yet they go out of "existence" without any special regret. The main fact is we can give numbers to these forces, temperatures, etc., and make equations that correspond (somewhat) to experiments.

Mass, on the other hand, means (1) inertia. (2) capacity to be attracted by a gravitational field (3) capacity to create a gravitational field, and some other things. It appears to depend on velocity, though it is not intended to consider non-Newtonian mechanics. It is about as puzzling a thing as there is in physics —for who knows what gravitation is?

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NONSILVERABLE CONTAINERS FOR SILVERING MIRRORS

In the ordinary process of silvering glass mirrors by chemical decomposition (*e. g.*, Brashear's method) the metal is deposited upon the glass container. In this manner a great deal of silver which might have added to the thickness of the mirror is lost. This is an important item when silvering mirrors 25 cm. or more in diameter.

The object of this note is to call attention to the usefulness of ordinary, "granite ware," enamelled iron pans, which do not attract the silver and hence increase the supply of material available for deposition on the mirror. This was observed some years ago, but its importance was not very apparent. However, during the past year the writer has had frequent opportunities to verify this observation and to apply it in producing thick deposits of silver on glass.

Wm. W. Coblentz

Bureau of Standards,
September 9, 1918

QUOTATIONS

SCIENTIFIC WORK IN INDIA

The Board of Scientific Advice for India has, like similar bodies elsewhere, felt the effect of war conditions. The board has been strengthened by the addition of a representative of the Indian Munitions Board, and power has been conferred upon the president to appoint subcommittees, membership of which need not be confined to members of the board, for the purpose of dealing with particular investigations. The board has found it necessary to modify the treatment of programs of work submitted by individual scientific departments, and to resolve that the annual report for 1916–17 be confined to a brief statement of work actually done during the year, also that the bibliography of publications bearing on particular subjects be consolidated. But the establishment of a Zoological Survey recorded for the year under notice, has not affected the composition of the Board of Scientific Advice, representation of this subject having been provided for already. That its organization should have been so slightly affected affords striking evidence of the soundness of the original constitution of the board.

The report of the board for 1916–17 is an interesting document, and much of its contents, especially where the applications of science are concerned, may repay perusal outside India. In agriculture the low values of

[3] "Matter and Energy," New York, 1912, p. 108.

available phosphate in certain Indian soils—at times only one fiftieth to one twentieth of the amount usually regarded as necessary for fertility—have been under investigation. So, too, have been the low values of available potash in certain other soils. In this connection efforts have been made not only to correlate potash-deficiency with disease in animals and plants, but also to utilize the ash of at least one proclaimed weed as a means of adding potash to the soil, and incidentally as a partial set-off against the cost of eradication. Botanical work has included, in addition to survey operations, much that is of immediate economic importance. One notable instance is afforded by the device of a method of selfing cotton, which is not only simple, but is also said to have proved successful. Much sound work has been done with indigo, jute, opium, rice, sugar and wheat on agricultural lines, and with grasses, as well as trees, on forestry lines.

On the physical side we find that researches in solar physics have included an investigation of the displacement of the lines given by the electric arc. This study has supplied interesting results, and led further to a determination of wave-lengths in the spectrum of the planet Venus with results that are of promise. In geology, besides survey operations, useful economic work has been done in connection with the output of wolfram. Three new meteorite falls—all chondrites—have been reported for 1916–17 from northern India. The most notable item of economic geodetic work for the year has been the taking of hourly readings of a tide-gauge at Basra, erected in connection with military requirements. The constants deduced from the reductions of these readings have been transmitted to the National Physical Laboratory at Teddington, to admit of the tracing of tidal curves for 1917–18. Important also has been the compilation of a list of the plumb-line deflection stations of India and Burma.

The work undertaken in connection with plant- and animal-pathology has been useful and varied. In this relationship an item which deserves attention is an account of practical tests of the use of hydrocyanic acid gas for the destruction of vermin. While less successful than might be desired in the case of houses, this method has proved satisfactory as regards railway carriages and ships.

Appended to the report is a memorandum on work done for India at the Imperial Institute. A striking item in this memorandum is the record of a sample of Assam-grown flax, valued in London under war conditions in December, 1916, at £150 per ton, which was found to compare favorably with the medium qualities formerly received from Belgium.

Perhaps the time is approaching when a body, similar in its functions to this Indian board, may be brought into being so as to ensure for the scientific departments of our various Crown Colonies that correlation of effort which, as this report testifies, already so happily attends the operations of the different scientific departments of the Indian government.—*Nature.*

SCIENTIFIC BOOKS

Plant Genetics. By JOHN M. COULTER and MERLE C. COULTER. The University of Chicago Press. 1918. Pp. 214.

As the authors state the book is neither a technical presentation of genetics nor a general text, but is the outgrowth of a course of lectures designed to give general students of botany a brief introduction to the subject of genetics. This has been attempted in some 200 small pages with numerous diagrams. It is written for younger students than the books on genetics which have so far appeared. Necessarily a minimum of illustrative material has been used and the complex features are omitted altogether or are only briefly alluded to.

An account of the earlier theories of heredity and a discussion of the inheritance of acquired characters opens the book followed by several chapters on Mendelism. The simplicity of the examples of the various types of Mendelism and the diagrams to illustrate them is a real achievement. Some misrepresentations of facts are to be noted here which are hardly

excusable even on the plea of pedagogical necessity. For example in the treatment of Mendel's pea hybrids the "wrinkled-smooth" seed character is given as similar in time of expression to the "tall-dwarf" plant character which in inheritance is one generation later in its apparent effect so that the statement that first generation dihybrid plants will all be tall and smooth-seeded individuals would be quite confusing to the beginning student if he repeated such an experiment for himself. For the purpose of illustrating the behavior of a dihybrid it serves the authors' purpose but there is certainly no lack of material which could be used equally well to illustrate this point without alteration of the actual facts.

The work of East, Shull, Emerson, Blakeslee and many others is freely drawn upon in bringing out the different phases of the subject. The chapters of chief interest to the geneticist are those on Parthenogenesis and Vegetative Apogamy, Inheritance in Gametophytes, and the Endosperm in Inheritance. A number of facts in regard to sex determination in plants have been gathered together. All these subjects have usually been scantily treated in books on genetics.

In the opinion of the writer the authors were not wise in including the complex subject of sterility in an elementary book of this kind especially as it is treated in the chapter on self-sterility. The beginning of the chapter emphasizes the importance of self-sterility as a means of insuring cross-pollination while the remainder is largely devoted to Belling's work on semi-sterility which has no significance in this connection. No clear distinction is made between the different types of sterility which would seem desirable if the subject is to be discussed at all. A chapter is devoted to the subject of hybrid vigor and the book closes with an able summary of the theoretical points involved in a consideration of the chromosomes as the bearers of the hereditary determiners.

Throughout there is shown a first-hand unfamiliarity with the genetical experiments discussed. In spite of this handicap a really useful book, for those not primarily interested in genetics, has been produced which shows the authors' ability to coordinate many different, specialized fields of investigation and to put the results into an easily read form. The book is designed to fill an important place which would justify more care in the choice of material and in its presentation. The practise followed of giving few facts and discussing them in all their important relations to each other and to other fields of biology is perhaps the most valuable feature of the book.

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THE POWER SITUATION IN THE UNITED STATES

Two of the most important domestic problems facing the United States at the present time concern the supply of power necessary to maintain the industrial activities of the country, and the adequacy of transportation to move the raw materials and finished products involved in these activities. As the coal consumed in the United States engages over a third of the freight capacity of our railroads, and more and more coal is being used, the result is a growing burden upon transportation which must be relieved. The power problem and the transportation problem, therefore, are really different expressions of a single fundamental issue. In this connection the United States National Museum, Smithsonian Institution, has just issued a 50-page Bulletin, entitled "Power: Its Significance and Needs," which gives an analysis of the whole situation and presents a plan whereby the problems of water-power, coal-supply, and transportation may find a solution. This contribution is by Chester G. Gilbert and Joseph E. Pogue, of the Division of Mineral Technology, and is Part 5 of Bulletin No. 102, the Mineral Industries of the United States, which has already dealt constructively with such matters as coal-products, fertilizers, domestic fuel and petroleum.

Quoting from the conclusions of the authors of this Bulletin, it is stated:

The righting of the power situation requires (1) the establishment of a comprehensive system of electric transmission lines to be administered as a common-carrier system like the railways. (2) The provision of such a system will necessitate the coordinated growth of central power stations in coal fields and at water-power sites, and in doing so will open to business enterprise a tremendous field of opportunity hitherto closed off from entry, and thus lead to the balanced development of the two major energy resources, coal and water-power. (3) The principle of multiple production, recognized and incorporated in national policy, will supplement the additional service gained through the organized employment of the electrical principle; applied to the production of coal-generated electricity, and, through the medium of municipal public utility plants, to the distributive employment of coal, this principle will effectively correlate the recovery of the commodity and energy values, so as ultimately to effect a full saving of the former and an increased gain of the latter, thus permitting a further relative diminution of the amount of fuel calling for transportation in bulky form. The first two points reduce themselves to a single issue, which is purely a business proposition to be handled by a business organization; the third item is more intangible and it is a matter of policy, which, therefore, can not be delegated or otherwise handled in objective fashion.

The provision of a common-carrier system of transmission lines, in brief, is the key to the whole problem. Its establishment will remove the retarding influence of high interest rates and antagonistic misunderstanding that has blocked water-power development, and will afford the point of departure from precedent in favor of coal-field generation of electricity. Owing to the magnitude of the issue and the manifold lines of progress directly at stake, the development will provide a nuclear point for the establishment of a constructive economic policy, needed not merely for the full development of this field but as well for proper unfoldment of the industrial possibilities of the country in general. As such a policy has not developed in the past because of economic sectionalism growing chiefly out of an unequalized development of the energy resources, the nationalization of industrial opportunity attainable through a balanced development of power supply will clear the path of the main obstruction to unified action.

Thus specific action in respect to establishing a common-carrier system adapted to the power needs of the country will not only go far toward solving the problem of transportation, but it will improve the fuel supply, correct the economic fallacy of drawing upon capital resources while neglectful of income, contribute to the recovery of the values now lost in the consumption of raw coal, lead to an adequate development of electrochemical activities, cut off a needless annual expenditure running well beyond the billion dollar mark, and constitute a potent contribution in the direction of stimulating the upgrowth of a constructive economic policy of national scope attuned to the needs of modern industrial development. It is believed that these results would involve national economies, offsetting in large part the cost of the war.

SPECIAL ARTICLES

THE COEFFICIENT OF EXPANSION OF LIVING TREE TRUNKS

The present investigation was undertaken as a continuation of the work of the late Professor C. C. Trowbridge, of the Department of Physics, Columbia University, on the movements of the branches of trees, with the object of inquiring into the mechanism of these movements. Part of the work had been carried out in collaboration with Professor Trowbridge.

The measuring apparatus, as devised by him, consisted of a rod of invar, with four steel knobs set on short steel posts fitted into the rod near one end, at intervals of ninety degrees, and also with one or more small brass blocks in the form of square prisms, fitted over the rod at some distance from that end. A steel-pointed block and a conical steel socket were attached to the tree under investigation, and a measurement was made by holding one of the steel balls in the socket, and making a light scratch on the brass plate by gently drawing it over the steel point. A careful record was kept of the exact position on the brass plate of each of the scratches made, and the distances between them were measured under the microscope. In the tests made previous to the tree-trunk work, the instrument was found to be suitable for general laboratory work as well as

[1] C. C. Trowbridge, "The Thermometric Movements of Tree Branches at Freezing Temperatures," *Bulletin of the Torrey Botanical Club*, 43, No. 1, pp. 29–56, 1916.

for special types of investigation. Together with each measurement a reading was taken of the air temperature as given by a mercury thermometer attached to the tree, as well as the reading of one or more thermometers inserted into the tree to various depths.

Observations were made on a European linden tree (*Tilia europæa*), and a plane tree (*Platanus orientalis*), both on the campus of Columbia University. The observations extended from February 2 to May 19, 1917, and from December 22, 1917, to April 25, 1918. During the first winter, observations were made on both of these trees, but attention was confined to the linden tree alone during the second winter, as the same effects were observable here to a far more marked degree. During both winters, longitudinal and transverse measurements were made, a separate point and socket being used for each, and a longer rod being used for the longitudinal observations, as the longitudinal changes were, as a rule, much smaller in amount. An extended series of measurements was also made on the changes in the circumference of the tree and on frost cracks, during the second winter. Three interior thermometers were used in the first winter's observations, four in the second, one extending to a somewhat greater depth than the deepest of the previous winter. No observations were made during the summer, as it was found that at ordinary and high temperatures, the changes in dimensions were extremely slight. Observations were made from one to four times a day, and readings of the various thermometers were sometimes taken more frequently. During the winter of 1917–18, the writer made 109 sets of measurements, and about the same number during the preceding winter.

The second winter's observations fully confirmed the earlier series, and added some new results. In regard to the transverse measurements, it was found that above 32° Fahrenheit there is a slight expansion with rise in temperature, while below that temperature the changes are far more marked. As the temperature falls below 32° Fahrenheit there is a very marked transverse contraction. The difference in the changes above and below freezing may best be illustrated by stating, in the case of the linden, that above the freezing temperature, the coefficient of expansion is nearly the same as that of dead wood, *i. e.*, of the order of 5×10^{-5}, while below freezing it is some fifty times as great.

The transverse change in dimensions of the tree, below freezing, usually lags behind the change in temperature of the bark by several hours at least, often as much as twenty-four hours. When there is a sudden change in the temperature of the bark, the contraction is rapid, but not synchronous. With a rise in temperature, the lag, as a rule, is relatively greater. It is probable that the temperature at a depth of four or five inches has little or no influence on the changes in transverse dimensions.

In the case of longitudinal measurements the fact was revealed that below the freezing temperature there is a minute but extremely definite *increase* in length with *fall* of temperature, and that above freezing, there is an equally minute *increase* with *rise* of temperature. At extremely low temperatures, near zero, Fahrenheit, however, there is a small *contraction* with fall of temperature, but when the temperature rises again, the expansion is extremely rapid, and by the time the temperature is again the same as before the drop, the tree is very much longer than previously.

In this series of measurements at very low temperatures, there is distinct evidence of two changes—thermal and physiological, apparently acting in opposite directions. At slightly higher temperatures the thermal change is not so much in evidence, and so, as a rule, only the physiological expansion with drop of temperature is observed. There is evidence of a lag of longitudinal expansion and contraction behind the temperature of the bark of the tree, but excepting at the lowest temperatures, the phenomenon is not clear cut, as in the case of the transverse measurements, and the details have not as yet been worked out.

A very extended series of measurements was made on the circumference of the linden tree,

and it was found that, as a rule, the expansions and contractions were in the same direction as for the transverse measurements, but yet this was not always the case. The changes in circumference were found not to be proportional to the transverse measurements. After more than four months, when the temperature was much higher than at the time observations were begun, the circumference of the tree was still *smaller* than when the first observations were made. The method of making observations on the circumference consisted in measuring, with a pair of dividers, the distance between two scratches on a painted steel tape surrounding the tree, and continuously left in contact with it. When the series of observations was begun, two scratches were made, one on each of the two parts of the tape which lay, one directly above the other, and, as the circumference changed, the distance between these scratches was recorded. These measurements were made several times a day, and showed that the final contraction, which Grossenbacher[2] thought might possibly be due to an error in his measurements, is an actual experimental fact. Grossenbacher's observations were made at intervals of several weeks, and his tape was removed after each observation.

An equally extended series of measurements on frost cracks was made during the winter of 1917–18. It was found that during the coldest weather when the crack was open about three fourths of an inch, its depth at certain points was more than ten inches. Also, in addition to the large crack formed on the south side of the linden tree, another was formed on the north side toward the end of January, 1918, and the change in the width of the two cracks seemed to follow the same law, *i. e.,* the cracks became wider as the temperature fell, and narrower as it rose again.

From the measurements on the transverse changes, on the circumference and on frost cracks, the conclusion was reached that frost cracks are caused by a tearing apart of the tissue of the tree, due to a great *contraction.* Both the circumference and the transverse dimensions are much less when the crack is open than when it is closed, and the one is not proportional to the other.[3] Frost cracks are probably due to a difference in the coefficients of radial and tangential contraction of the tree, a difference which sets in at approximately 25° Fahrenheit (about 4 degrees below zero Centigrade). If the cells of the tree collapse in a tangential direction (a fact which was observed) and the changes along the medullary rays are not as great, then the tree will split open, due to the increased tension. If the cells again expand tangentially, the crack will close due to increased pressure, provided the radius may not change in dimensions at all, it may expand to a greater extent, or it may even contract; in any case the crack will close. The first or third of these cases would account for the observation that after the crack has closed, the circumference of the tree is less than before it opened. These conclusions are, however, tentative and approximate, due to the complications caused by the lag in the tangential direction, the temperature gradient through the tree, and other difficulties which must still be studied, before a more complete explanation can be given.

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[2] J. G. Grossenbacher, "Crown-Rot of Fruit Trees, Field Studies," N. Y. Agricultural Experiment Station, Geneva, N. Y., Technical Bulletin, No. 23, September, 1912, pp. 35–37.

[3] Some similar conclusions were reached by a different method by Caspany, *Bot. Zeit.,* 15, 1857.

[4] Deceased.

THE DEPTH OF DOLOMITIZATION[1]

In a recent issue of the *American Journal of Science,*[2] there appeared an article by E. W. Skeats on "The Formation of Dolomite and its Bearing on the Coral Reef Problem." The author of this paper adopts the replacement theory of the origin of dolomite and presents

[1] Published with the permission of the Director of the Iowa Geological Survey.

[2] Volume XLV., 4th Series, pp. 185–200, March, 1918.

evidence in favor of the view that regional dolomites are of shallow water origin. The bearing of this conclusion upon the coral reef problem is made clear from the following quotation:[3]

The author regards the evidence of dolomitization of fringing reefs of coral islands, the occurrence of dolomite immediately below phosphate beds, on the hill tops of Christmas Island, the rise in the magnesian content of the limestones of the Funafuti bore between 15 and 30 feet, as definite and strong evidence of the shallow water origin of dolomite in coral islands. It is claimed that this view is consistent with the chemical evidence quoted above of the reversal of the solubilities of calcium and magnesium carbonates in carbonated water between the pressures of one and four atmospheres. In addition, the evidence, cited above from more ancient dolomites showing their intimate associations with independent evidence of shallow water such as fossils, current bedding, conglomerates, and oolitic structures, is so consistent and so in accordance with the evidence from modern coral limestones, that the author takes the view that wherever a "contemporaneous" or regional dolomite is found to occur, it may be regarded as having originated in shallow water. If this be granted, it follows that such upraised coral islands, like Ngillangillah, now 510 feet high, and Vatu Vara, now 1,030 feet high, which are dolomitized from top to bottom, must have originally been formed of shallow water limestones accumulated by subsidence to at least 500 to 1,000 feet respectively before elevation set in. The atoll of Funafuti whose surface is practically at sea level must have been built up of shallow water limestones accumulated during subsidence, which must have amounted to about 1,100 feet at least since the cores from 635 feet to 1,114 feet consist entirely of limestones which have passed through the process of dolomitization.

In the writer's experience with regional dolomites of undoubted secondary origin, he has encountered considerable evidence in support of the contention that many of them represent shallow water deposits, but he is not yet prepared to conclude that all replacement dolomites are of this origin. The most striking evidence bearing on this question that has come to the writer's attention, has been obtained in connection with his study of the limestones of the Osage and Meramec series, of Mississippian age, in the Mississippi Valley.

[3] *Ibid.*, p. 200.

In Ste Genevieve county of southeastern Missouri, these limestones, with one exception, possess all the ear-marks of clear, open sea deposits (see table). They attain their maxi-

TABLE

Series	Name of Formation	Thickness in Feet
Meramec	Saint Louis limestone	150
	Spergen limestone	160
Osage	Warsaw formation	150
	Keokuk limestone	30–40
	Burlington limestone	75

mum development there, are all, with the exception of the Warsaw, unusually pure, and, barring a small break of local significance at the base of the Warsaw, are conformable. The paucity of dolomite in this thick series of limestones is remarkable. With the exception of an impure bed of dolomitic limestone in the upper portion of the Warsaw, which may well be of clastic origin, and a thin, imperfectly dolomitized layer in the Saint Louis at the station of Little Rock, no dolomite was observed during a careful study of the whole section.

In southeastern Iowa and adjacent portions of Illinois, on the other hand, very different conditions are met with. In this region all the formations show indications of having been deposited in shallow, oscillating seas, the evidence being most pronounced in the Spergen and Saint Louis limestones, and dolomite is a very important constituent of every member of the series.

The Burlington limestone maintains approximately the same thickness here as in southeastern Missouri, but beds of brownish, impure dolomite, some of which pass locally into shale, are interbedded with the limestone and constitute more than fifty per cent. of the formation.

The Keokuk consists of interbedded layers of shale and limestone, some of the latter being dolomitized locally; and the Warsaw is made up chiefly of argillaceous shale but bears occasional lenticular beds of limestone, some of which are imperfectly dolomitized.

The Spergen limestone of southeastern Iowa

is very different from that of southeastern Missouri, and much confusion attended the earlier attempts to refer this formation to its proper position in the series. This confusion was evidently due, in large part, to the failure of earlier workers to recognize the disconformities at the base and at the top of the formation. The apparent tendency of the Spergen to grade laterally into the Warsaw or the Saint Louis has resulted entirely from these relationships. In addition, the Spergen is very variable in lithologic character in this region, due in part to original conditions of sedimentation, and in part to differences in the degree of dolomitization. It is not uncommon to find a cross-bedded, crinoidal limestone passing laterally within a short distance through imperfectly dolomitized limestone into massive, brown dolomite, and this again into a brownish arenaceous dolomite, which may in turn give way to a fine-grained, bluish sandstone. Such rapid changes clearly indicate near-shore conditions during deposition. This is also suggested by the limited extent of the formation in Iowa. and by its rapid thinning to the northwest. Its thickness in this region varies from 0 to 35 feet.

The Saint Louis limestone of Iowa also shows marked evidence of shallow conditions during deposition, although it has a much more widespread distribution than the Spergen. It consists of two distinct subdivisions separated from one another by a disconformity. For convenience these may be designated as the Lower Saint Louis and the Upper Saint Louis. The Lower Saint Louis is by far the most extensive of the two members. This extends far to the northward, overlapping all the earlier formations of the Mississippian except the Kinderhook, upon which it rests in Humboldt county. It consists for the most part of massive beds of compact, dolomitic limestone, but frequently these are found to grade laterally into gray, non-dolomitic limestone within short distances. At most localities, the lower beds are arenaceous. Ripple marks and cross-bedding may appear locally at any horizon. In southeastern Iowa, mound-like reefs of limestone with undisturbed layers lapping up on their flanks are occasionally found in the formation. These were evidently formed by wave action during deposition. The thickness of this division is about thirty feet. The Upper Saint Louis consists for the most part of light gray compact limestone which is locally dolomitized either wholly or in part, and shows the same evidence of shallow water deposition as the Lower. Locally this division passes laterally into sandstone in part. The Upper Saint Louis seldom exceeds twenty-five feet in thickness.

The writer has observed further evidence of the relation of the extensive dolomitization to the shallow water zone in the Cedar Valley limestone, of Upper Devonian age, in Iowa. In Johnson county, which is located a short distance south of the east-central portion of the state, this formation has an exposed thickness of approximately one hundred feet and consists of fairly pure, gray fossiliferous limestone almost entirely devoid of dolomite. But in Mitchell, Howard, Winneshiek and other counties in the northern portion of the state, the Cedar Valley is made up of interbedded limestone and dolomite, and bears evidence of having been deposited in shallow seas. The beds are impure, shaly partings are common between the layers, and evidences of contemporaneous erosion are frequently encountered.

The suggestion is ventured that careful study of other Paleozoic limestones will disclose similar evidence of more extensive dolomitization in their shallow water facies.

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